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GENERAL PRINCIPLES AND INVESTIGATION OF FORMULÆ.

In making excavations through earth, it is customary to give some inclination or slope to the sides of the cuts to prevent the banks from sliding in and filling the roadway. The degree of inclination is always indicated by the distance the slope recedes from a perpendicular in a height one.

Thus, if the deviation from the perpendicular is equal to the depth of the cut, (or the inclination is 45°,) the side banks are said to have a slope of 1, or, as it is frequently expressed, of 1 to 1. If the deviation is $\frac{1}{2}$ the depth, the slope is $\frac{1}{2}$ to 1.

In excavations through rock, or very hard clay, a slope of $\frac{1}{2}$ to 1 is generally used; common earth stands at a slope of 1 to 1, but very sandy soil requires a slope of $1\frac{1}{2}$ to 1. The section of an embankment is precisely similar to that of an excavation inverted, and therefore all the rules, formulæ and tables are alike applicable to both descriptions of work.

In embankments it is not considered prudent ever to adopt a less slope than $1\frac{1}{2}$ to 1, unless the earth is supported by side walls.

In explaining the methods we use for the calculation of the solid contents of earth work, we shall first consider those cases where there is no slope in the ground transversely, or at right angles to the direction of the centre line of the road.

Let D be the depth of an excavation at any point,

    B   the width of the base,

    m the slope of the side banks or distance they recede from the perpendicular in a height one.

Then $B + 2\,m\,D =$ width of excavation on top,

        $B + m\,D =$ average width,

and $(B + m\,D)\,D =$ area of the cross section.

Hence if the depth were uniform throughout a length L the content would be

$$(B + m\,D)\,D\,L \quad - \quad - \quad - \quad - \quad - \quad (A)$$

From this expression the tables of average depths are calculated.

We will now suppose D and d to be the depths at the two extremities of an excavation, the surface being understood to vary uniformly between these

points.   Then the content of the included solid will be found by multiplying the sum of the end areas and four times the area of a middle section by one-sixth of the length.   (See page 141 Bonnycastle Mensuration.)

The end areas are $\qquad$ $(B + m\,D)\,D,$

and $\qquad$ $(B + m\,d)\,d,$

four times the area of middle section $2\,B\,(D + d) + m\,(D + d)^2.$

Hence the content is

$$\left\{ 3\,B\,(D + d) + m\,D^2 + m\,d^2 + m\,(D + d)^2 \right\} \frac{L}{6}$$

$$= \left\{ 6\,B\,(D + d) + 4\,m\,D^2 + 4\,m\,D\,d + 4\,m\,d^2 \right\} \frac{L}{12} \quad - \; - \text{(B)}$$

Now the content of a cut of an uniform depth throughout of $\frac{1}{2}\,(D + d)$, found by substituting $\frac{1}{2}\,(D + d)$ for D in equation (A) will be

$$\left\{ B + \tfrac{1}{2}\,m\,(D + d) \right\} \frac{D + d}{2} \times L$$

$$= \left\{ 6\,B\,(D + d) + 3\,m\,D^2 + 6\,m\,D\,d + 3\,m\,d^2 \right\} \frac{L}{12}.$$

The difference between this content for the average depth of $\frac{1}{2}\,(D + d)$, and the content of a cut the depth of which is D at one end, and d at the other, as given in formula (B,) is

$$(m\,D^2 - 2\,m\,D\,d + m\,d^2)\,\frac{L}{12},$$

or $\qquad (D - d)^2\,\frac{m\,L}{12}. \quad - \qquad \cdot \qquad \cdot \qquad \cdot \qquad \cdot \quad \text{(C)}$

It appears from this, that the correction to be added to the content obtained from the average depth, varies as the square of the difference of the depths at the two extremities of the excavation ; and that, therefore, if a table is calculated expressing the values of equation (C) for different values of $(D - d)$ we can readily ascertain the content of any excavation, by addition of the numbers taken from this table to the content found in the table of average depths and corresponding to a depth of $\frac{1}{2}\,(D + d)$.

The tables numbered VII, XIV and XXI, and headed " *Corrections for Differences,*" are computed from formula (C), and adapted to this purpose.

It is customary with many engineers to multiply the half sum of the end areas by the length for the content.   The half sum of the end areas multiplied by the length is

$$(B\,D + B\,d + m\,D^2 + m\,d^2)\,\frac{L}{2}$$

$$= \left\{ 6\,m\,(D + d) + 6\,m\,D^2 + 6\,m\,d^2 \right\} \frac{L}{12}$$

from which deduct the true content as in equation (B), and there remains

$$(2\,m\,D^2 - 4\,m\,D\,d + 2\,m\,d^2)\,\frac{L}{12} = (D - d)^2\,\frac{m\,L}{6}.$$

It will be perceived that the amount of error is exactly double the whole

" correction for differences." In a cut 100 feet long, 30 feet deep at one end, and 3 feet at the other, having a slope of $1\frac{1}{2}$ to 1, there would be an excess in the return of work thus estimated on this short distance, of 675 cubic yards.

We will now consider those cases where there is an inclination in the natural surface of the ground in a direction at right angles to the centre line of the road.

Fig. 1.
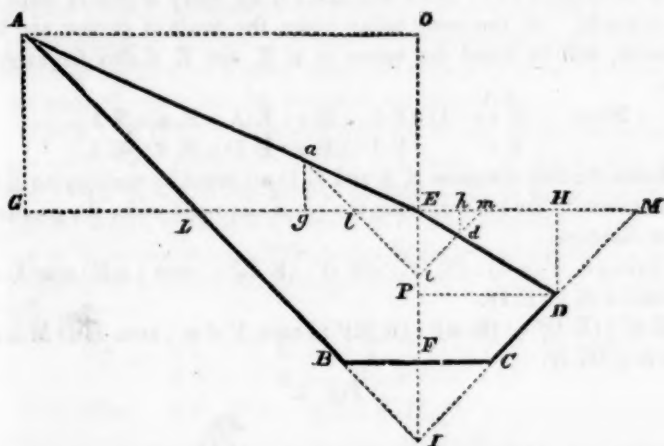
Let A B C D E (fig. 1) be a transverse vertical section of an excavation, where B C is the base, A B and C D the sloping sides, E F the centre cutting, and A E D the natural surface. Draw L E M parallel to B C (cutting the side slopes at L and M), and A G and D H perpendicular to it. Since the area A B C D = L B C M + A E L — D E M, the content of a prism whose base is A B C D, and length L, may be found by adding to the content of the prism having the base L B C M, (which will be taken from the table of averages,) the difference of the prisms whose bases are the triangles A E L and D E M respectively. But area A E L = $\frac{1}{2}$ E L × A G and area E D M = $\frac{1}{2}$ E M × D H. Hence $\dfrac{A\,G - D\,H}{2} \times E\,L \times L$ is the correction for the transverse slope, which must be added to the average content to give the true content of the solid whose section is the figure A C. When the depth of cutting at the points A and D has been ascertained, A G and D H are known, being the difference of elevation of the points A and D and the centre E. We may also remark that E L or E M is equal to B F $+ m \times$ E F. Where the inclination of the ground is not very great, it will be found sufficiently accurate for all purposes, and much more expeditious, after having run the centre line to take the transverse slope in degrees right and left of the centre. Wm. J. Young, of Philadelphia, has made a very neat little slope instrument expressly for this purpose.

When the transverse slopes have been ascertained in degrees, the corrections will be found by means of a table which will now be explained.

Produce A B, E F and D C until they meet in Í. On E I lay off E i = 1 and draw $a\,i$, $i\,m$ parallel to A I and D I cutting A E, E L, E D and E M in a, l, d, and m; and draw $a\,g$ and $d\,h$ perpendicular to G M. Then the areas $a\,i$ E, E $d\,m$ are equal respectively to $\frac{1}{2}\,a\,g\times$ E i and $\frac{1}{2}\,d\,h\times$ E m, and are to be found under the head of greater and lesser areas in tables XXIII, XXIV, XXV and XXVI, for every degree of slope from 1º upwards. In the same tables under the heads of greater and lesser distances, will be found the values of a E, and E d also for every degree.
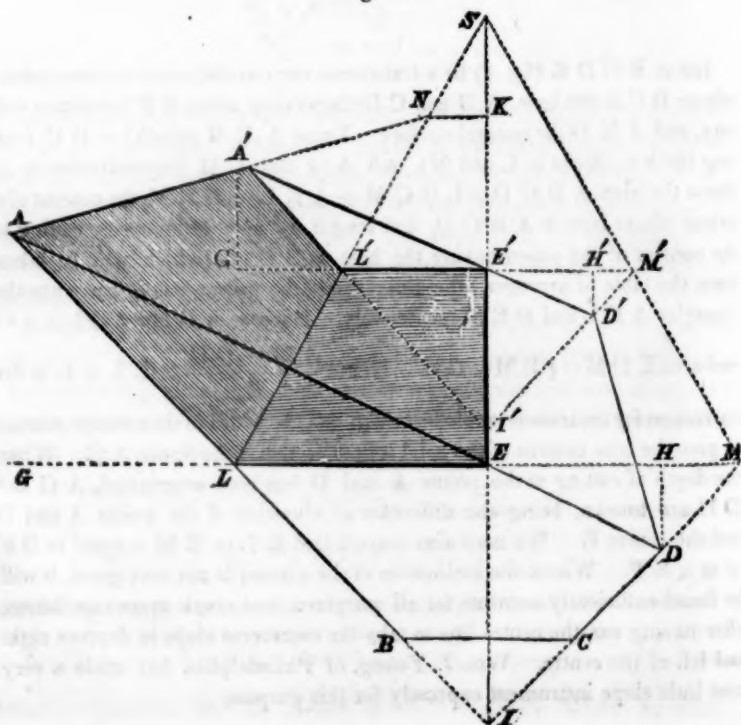
Now,   E $i\,(=1)$: E I : : E a : E A $=$ E $a\times$ E I
          E i : E I : : E d : E D $=$ E $d\times$ E I.

Hence the side distances E A and E D are found by multiplying E I by the numbers in the table opposite the given slope and under the greater and lesser distances.

Again, (E $i)^2\,(=1)$: (E I)^2 : : (E $l)^2$: (E L)^2 : : area $l\,a$ E : area L A E $=$ area $l\,a$ E $\times$ (E I)^2.

(E $i)^2$: (E I)^2 : : (E $m)^2$: (E M)^2 : : area E $d\,m$: area E D M $=$ area E $d\,m\times$ (E I)^2.

Fig. 2.

Hence the true correction for a length L is $(l \, a \, \text{E} - \text{E} \, d \, m) \times \text{E} \, \text{I}^2 \times \text{L}$.

Now, $\text{E} \, \text{I}^2 \times \text{L}$ is the content of a square prism, whose base is E I, and length L; and table XXII shows the content in cubic yards of prisms 100 feet long for square bases from 1 to 200 feet. Hence the value of $\text{E} \, \text{I}^2 \times \text{L}$ reduced to cubic yards may be taken from this table.

It will generally be found sufficiently accurate to consider the average slope in degrees as the uniform slope, and the average depth as the uniform depth throughout the cut. But as this is not always the case, it is desirable to have a true expression for the correction where the depths of cutting (and consequently the width on top) and the transverse slopes are variable. We will then see how far a mean depth and slope may be used without introducing material errors into the results of our calculation.

Let A L E (Fig. 2) represent a vertical section of that part of an excavation which rises above the centre E, A L being the sloping side of the cut, and A E a section of the natural surface. Let A′ L′ E′ be a similar and parallel section situated at a distance E E′ from the plane A L E. On E L and E′ L′ produced, let fall the perpendiculars A G and A′ G′; produce E E′ and A A′ to meet L L′ produced in S and N and draw K N parallel to E L or E′ L′.

Put $\text{E L} = \text{T}, \text{E}' \, \text{L}' = \text{T}', \text{A G} = \text{P}, \text{A}' \, \text{G}' = \text{P}'$
         $\text{E E}' = x, \text{E S} = \text{M and E K} = \text{M}'.$

Then $\text{E S} : \text{E}' \, \text{S} :: \text{E L} : \text{E}' \, \text{L}',$

or $\text{M} : \text{M} - x :: \text{T} : \text{T}' = \text{T} - \dfrac{\text{T} \, x}{\text{M}}.$

and $\text{E K} : \text{E}' \, \text{K} \, (:: \text{L N} : \text{L}' \, \text{N}) :: \text{A G} : \text{A}' \, \text{G}',$

that is $\text{M}' : \text{M}' - x :: \text{P} : \text{P}' = \text{P} - \dfrac{\text{P} \, x}{\text{M}'}.$

Now the area $\text{A}' \, \text{L}' \, \text{E}' = \frac{1}{2} \, \text{T}' \, \text{P}' = \frac{1}{2} \left(\text{T P} - \dfrac{\text{T P} \, x}{\text{M}'} - \dfrac{\text{T P} \, x}{\text{M}} + \dfrac{\text{T P} x^2}{\text{M}' \, \text{M}} \right)$

But if S = content of the solid E A′ the differential of $2 \, \text{S} = 2$ area A′ L′

$$\text{E}' \times d \, x = \text{T P} \, d \, x - \dfrac{\text{T P} \, x}{\text{M}'} \, d \, x - \dfrac{\text{T P} \, x}{\text{M}} \, d \, x + \dfrac{\text{T P} \, x^2}{\text{M M}'} \, d \, x.$$

Hence by integrating this equation we have

$$2 \, \text{S} = \text{T P} \, x - \dfrac{\text{T P} \, x^2}{2 \, \text{M}'} - \dfrac{\text{T P} \, x^2}{2 \, \text{M}} + \dfrac{\text{T P} \, x^3}{3 \, \text{M M}}.$$

Substituting for M and M′ in this equation their values $\dfrac{\text{T} \, x}{\text{T} - \text{T}'}$ and $\dfrac{\text{P} \, x}{\text{P} - \text{P}'}$ and putting L for x we have

$$\text{S} = (2 \, \text{T P} + 2 \, \text{T}' \, \text{P}' + \text{T}' \, \text{P} + \text{T} \, \text{P}') \dfrac{\text{L}}{12} \qquad . \qquad . \qquad (\text{D})$$

This is a general expression for the content of a solid bounded on two sides by planes, and on the third by a warped surface.

If B C (fig 2) represents the base B, $\text{I F} = \dfrac{\text{B}}{2 \, m}$, $\text{E I} = \text{D} + \dfrac{\text{B}}{2 \, m} = \text{H}$

and E′ I′ = H′, then T = E L = $m \times$ H and T′ = E′ L′ = $m \times$ H′. These values of T and T′ substituted in the last equation give us for the content

$$(2\,H\,P + 2\,H'\,P' + H'\,P + H\,P')\,\frac{m\,L}{12},$$

which is the excess in cutting caused by the slope of the ground rising above the centre line of the excavation ; and if H D and H′ D′ (fig. 2) be put $= p$ and p', the deficiency caused by the slope falling below the centre will be

$$(2\,H\,p + 2\,H'\,p' + H'\,p + H\,p')\,\frac{m\,L}{12},$$

and the true correction is evidently equal to the difference of these expressions, or

$$\left\{ (2\,H + H')\,(P - p) + (H + 2\,H')\,(P' - p') \right\}\,\frac{m\,L}{12} \quad \cdot \quad (E).$$

Had we taken $\dfrac{P + P'}{2}$ in place of P and P′, and $\dfrac{p + p'}{2}$ for p and p', or the mean of the perpendiculars P, p, P′ and p′, the correction would have been

$$(H + H')\,(P - p + P' - p')\,\frac{m\,L}{8} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad F,$$

which if substracted from equation (E) leaves a second correction

$$(H - H')\,(P - p - P' + p')\,\frac{m\,L}{24} \quad \cdot \quad \cdot \quad \cdot \quad (G).$$

These are in a more convenient form than equation (E), as (G) may, when of little importance, be omitted.

When $P - p = P' - p'$ equation (E) becomes

$$(H + H')\,(P - p)\,\frac{m\,L}{4} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (H).$$

When the depth is uniform but not the slope we have

$$H\,(P - p + P' - p')\,\frac{m\,L}{4} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (I).$$

And finally, when slope and depth are both uniform.

$$H\,(P - p)\,\frac{m\,L}{2} \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (K).$$

These expressions for " corrections for transverse slopes" are in the most convenient form, if the heights of the points A and D (figures 1 and 2) are found without the use of the slope instrument, and they do not require the use of the tables.

Let $P = \dfrac{2\,A\,H}{m}, p = \dfrac{2\,a\,H}{m}, P' = \dfrac{2\,A'\,H'}{m}$ and $p' = \dfrac{2\,a'\,H'}{m}$, (where A, a, A′ and a′ are the areas A L E, E D M, A′ L′ E′ and E′ D′ M′ (fig. 2) when H and H′ are each = 1) then expression (E) becomes

$$\left\{ 2\,H^2\,(A - a) + 2\,H'^2\,(A' - a') + H\,H'\,(A - a + A' - a') \right\}\,\frac{L}{6},$$

which, if we assume the slope uniform throughout the excavation, becomes

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (A - a + A' - a') \frac{L}{12}, \quad \text{(L)}$$

and this subtracted from the above equation leaves us a second correction

$$(H^2 - H'^2)(A - a - A' + a') \frac{L}{6}. \quad \cdot \quad \cdot \quad \cdot \quad \text{(M)}$$

When the slope is uniform throughout, our expression becomes

$$\left\{ H^2 + H'^2 + (H + H')^2 \right\} (A - a) \frac{L}{6}. \quad \cdot \quad \cdot \quad \cdot \quad \text{(N)}$$

But if we had taken the mean depth $\frac{H + H'}{2}$ as the uniform depth we should have had for the correction

$$(H + H')^2 (A - a) \frac{L}{4},$$

which subtracted from equation (N) leaves a remainder

$$(H - H')^2 (A - a) \frac{L}{12}. \quad \cdot \quad \cdot \quad \cdot \quad \text{(O)}$$

When the depth is uniform, but not the slope, we have

$$H^2 (A - a + A' - a') \frac{L}{2}. \quad \cdot \quad \cdot \quad \cdot \quad \text{(P)}$$

And when the slope and depth are both uniform

$$H^2 (A - a) L. \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \text{(Q)}$$

These expressions for " corrections for transverse slopes" are useful when the slopes are taken in degrees, and their values can readily be found by means of the tables of areas and table XXII.

There is another method of calculating the contents of excavation and embankment, which is more convenient when the slopes are very great and the depths variable, which will now be explained.

In fig. 1, draw A O and D P parallel to B C, meeting I E and I E produced in O and P. Put E I = H, A O = W, and D P = w, and let the corresponding dimensions of a parallel section situated at a distance L from A D I be represented by H' W' and w' respectively.

By substituting H and W for T and P, and H' and W' for T' and P' in equation (D), we have for the content of the solid included between A E I and its corresponding section

$$(2 H W + 2 H' W' + H' W + H W') \frac{L}{12},$$

and the content of the solid formed on D E I is

$$(2 H w + 2 H' w' + H' w + H w') \frac{L}{12}.$$

From the sum of these contents subtract the content of the prism having for a base the triangle B C I and we have for the content of the solid formed on A B C D.

$$\left\{ (2 H + H')(W + w) + (H + 2 H')(W' + w') \frac{L}{12} - \frac{B^2 L}{4 m}. \quad \cdot \quad \text{(R)} \right.$$

Let Y, y and Y′ $y′$ represent the ratio of W. w, and W′, $w′$ to H and H′ respectively on the values of W, w and W′, $w′$ when H and H′ are each = 1. Then by substitution the above equation for the content becomes

$$\left\{ 2\,H^2(Y+y) + 2\,H'^2(Y'+y') + H\,H'\,(Y+y+Y'+y') \right\} \frac{L}{12} - \frac{B^2\,L}{4\,m}.$$

If we assume the slope as uniform we have for the content

$$\left\{ H^2 + H'^2 + (H+H')^2 \right\} (Y+y+Y'+y')\frac{L}{24} - \frac{B^2\,L}{4\,m}, \quad \cdot \quad (8)$$

which subtracted from the above equation leaves a remainder

$$(H^2 - H'^2)(Y+y-Y'-y')\frac{L}{12}. \quad \cdot \quad \cdot \quad (T)$$

When the transverse slope is constant the content is

$$\left\{ H^2 + H'^2 + (H+H')^2 \right\} (Y+y)\frac{L}{12} - \frac{B^2\,L}{4\,m}. \quad \cdot \quad \cdot \quad (V)$$

If the depth is uniform but not the slope the content is

$$H^2\,(Y+y+Y'+y')\frac{L}{4} - \frac{B^2\,L}{4\,m}. \quad \cdot \quad \cdot \quad (W)$$

When the slope and depth are both uniform

$$H^2\,(Y+y)\frac{L}{2} - \frac{B^2\,L}{4\,m}. \quad \cdot \quad \cdot \quad \cdot \quad (X)$$

The values of Y y Y′ and $y′$ for every degree of slope from 1° upwards are given in tables XXIII, XXIV, XXV and XXVI under the head of greater and lesser horizontal distances and by means of these and table XXII the values of these equations can easily be ascertained.

If there is no transverse slope we will have

$$\left\{ \frac{(H+H')^2}{2} + \frac{(H-H')^2}{12} \right\} m\,L - \frac{B^2\,L}{4\,m}. \quad \cdot \quad \cdot \quad (Y)$$

Here it may be observed that the value of $\dfrac{(H-H')^2}{12}\,m\,L$ is given in the table of "corrections for differences No. XIV * and that the other terms of the equation are found in table XXII.

Finally, if there is no slope and no variation in depth the equation becomes

$$H^2\,m\,L - \frac{B^2\,L}{4\,m}. \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad (Z)$$

NOTE.   If H^2 or H'^2 is substituted for $(H-H')^2$, this remark will apply to all the formulæ in which L is divided by 12. The numbers in table XIV are $\frac{1}{12}$ of those in table XXII.   If $m = \frac{1}{2}$ or $= 1\frac{1}{2}$ the expression $\dfrac{(H-H')}{12}$ m L will be found in table VII or XXI, but if m is any other number, the expression must be found in table XIV and multiplied by m.

ON THE CALCULATION OF THE TABLES.

The labor of forming tables for calculating earth work may be very much abridged, by obtaining the first and second differences.

In any expression of the form $a x + b x^2 = n$, let x be increased by a constant quantity y and become $x + y$, $x + 2 y$, $x + 3 y$, $x + 4 y$, etc.: then the successive values of n will be

$$a x + b x^2$$
$$a x + a y + b x^2 + 2 b x y + b y^2$$
$$a x + 2 a y + b x^2 + 4 b x y + 4 b y^2$$
$$a x + 3 a y + b x^2 + 6 b x y + 9 b y^2$$
$$a x + 4 a y + b x^2 + 8 b x y + 16 b y^2, \text{ etc.}$$

Take the difference between each of these expressions and the following one, and we have

$$a y + 2 b x y + b y^2$$
$$a y + 2 b x y + 3 b y^2$$
$$a y + 2 b x y + 5 b y^2$$
$$a y + 2 b x y + 7 b y^2$$

These are called the first differences and the difference of these differences

$$2 b^2 y$$

is called the second difference.

Hence commencing with the first of the first differences, the continued addition of the second difference produces the several first differences, and these added in order to the first value of n will give the successive values of n. If the equation is of the form $b x^2 = n$, or a becomes o, then the first difference is $2 b x y + b y^2$, and the second difference is $2 b y^2$, as before found.

Let us apply this method to the calculation of the tables of contents for average depths. The expression for the content is (equation A)

$$(B + m D) D L = B L D + m L D^2.$$

Hence if we suppose D to be increased constantly by a quantity d, the Ist first-difference, found by substituting D and d for x and y, and B L and m L for a and b will be

$$(B d + 2 m D d + m d^2) L,$$

and by a similar substitution we shall find for the second difference

$$2 m d^2 L.$$

Let it be required to calculate the contents answering to every foot in depth for a length of 100 feet, base of 25 feet, and slope of $\frac{1}{2}$ to 1.

Here $B = 25$, $L = 100$, $m = \frac{1}{2}$, $D = 1$, and $d = 1$, and since these quantities are given in feet, our several results must be divided by 27 to reduce them to cubic yards.

Now $(B + m D) D L = \dfrac{25 \cdot 5 \times 100}{27} = 94 \cdot 444 = $ content for one foot.

$(B d + 2 m D d + m d^2) L = \dfrac{26 \cdot 5 \times 100}{27} = 98 \cdot 148 = $ 1st first difference.

And $2 \, m \, d^2 \, \mathrm{L} = \dfrac{100}{27} = 3\cdot7037 = $ second difference.

Hence the table will be calculated as exhibited below; the first differences being severally formed by addition of the second difference to the preceding one, and the table of contents by the addition of the corresponding first difference to the preceding content.

Depth feet.	First Dif. cub. yds.	Content. cub. yds.
1		94·444
2	98·148	192·592
3	101·852	294·444
4	105·556	400·000
5	109·529	509·259
6	112·963	622·222
7	116·667	738·889
8	120·731	859·260
9	124·074	983·333
10	127·778	1111·111

Let us apply this method to the calculation of a table of corrections for differences and in the equation (C) $(\mathrm{D} - d)^2 \times \dfrac{m \, \mathrm{L}}{12}$ put D′ for $\mathrm{D} - d$ and let it be constantly increased by a given quantity d'. Then

$$(2\,\mathrm{D}'\,d' + d'^2)\,\dfrac{m\,\mathrm{L}}{12} = \text{1st first difference,}$$

and
$$\dfrac{d'^2\,m\,\mathrm{L}}{6} = \text{second difference.}$$

If L $= 100$, D′ $= 1$, $d' = 1$, and $\dot{m} = 1$, the 1st first difference reduced to cubic yards is ·92593, and the second difference reduced also to cubic yards is ·61728. Hence the table will be calculated as follows:

Dif. of depth in feet.	First dif. cub. yds.	Correction cub. yds.
1		·30864
2	·92593	1·23457
3	1·54321	2·77778
4	2·16049	4·93827
5	2·77778	7·71605
6	3·39506	11·11111
7	4·01234	15·12345
8	4·62963	19·75308
9	5·24692	25·00000
10	5·86420	30·86420

BEAR MOUNTAIN RAILROAD.

Having completed the location of the Bear Mountain railroad, and the work being now under contract, and in progress of construction, I have thought that a statement of our operations thus far, and a brief description of the general features of the road, might be interesting to the readers of the Journal.

This road is intended for the transportation of the Bear valley coal from the mines to the canal, and, as originally chartered, was to extend from Rausch Gap, in Schuylkill county, through Lykens valley, to the head of the Wiscinisco canal, (unfinished) nineteen miles above Dauphin. Previous to my taking charge of the survey, some instrumental examinations had been made to ascertain the feasibility and probable cost of the road through Lykens valley, and from these examinations, it was ascertained that a route could be obtained through this valley, with grades either level or descending from the mines to the canal, and with a maximum grade of 36 feet per mile.

The principal business which this road would probably transact, consists in the transportation of coal and iron in one direction, and the great rivalry now existing between the parties interested in the several coal regions, renders it necessary that the cost of this transportation should be as low as possible. In order to ascertain the practicability of obtaining a less objectionable route for the road than the one originally contemplated through Lykens valley, I was induced to give a most rigid and thorough examination to the several valleys which head near the western extremity of this coal field ; and as the result of these examinations, we have adopted a route wholly different from the one originally contemplated, by which a saving of 14 miles of transportation is effected, with a termination at Dauphin, 19 miles lower down on the canal, and but 8 miles above Harrisburgh. In addition to this the road, as now located, has for its entire length (upwards of 30 miles) *a continuous descending grade of not less than* 16½, *nor more than* 17½ *feet per mile, with but two points on the line where the grade changes, and the minimum radius of curvature is* 1910 *feet.*

I am not aware that there is any railroad in the United States, or in the world, which, either for the whole, or any considerable portion of its length, is so admirably adapted for the cheap transportation of freight in one direction, and in fact, as far as the grades of a railroad affect the cost of transportation, I consider that our road is so located as to reduce this sum to a minimum.

It is difficult to say what is the greatest load that a locomotive could take down our road, but the average loads of an engine will of course be limited by the number or weight of empty cars with which it could return to the mines, ascending a grade of 17½ feet per mile.

It will readily be seen that our facilities for transacting a heavy freight business are greater than upon any railroad yet constructed. and that for the

peculiar kind of transportation, this road is over **40** per cent. better than a perfectly level road.

Our road has several other distinctive features ; and is, in many other respects, of a most extraordinary character.

My business engagements at present, however, will not permit me to enter more into detail ; but as soon as I have leisure, I shall be happy to furnish the Journal with sketches and drawings of several of our works of art, together with a more full description of the road and machinery.

<div align="right">J. SPAULDING,</div>

Dauphin, April 18, 1844.   *Chief Engineer B. M. Railroad.*

<div align="center">COAL TRADE.</div>

We have received a pamphlet of some **70** pages on the " Reading railroad company," by " Examiner ;" being " a series of articles published in the Pennsylvanian in January, February and March, 1844." The object is to counteract the " incendiary publications" issued in 1839 and 1840, by the Reading railroad company. The speedy downfall of this company is predicted with great confidence, and an elaborate demonstration is gone into— one of the main arguments being the rapid wear of the iron rails, a subject on which much has been written for this Journal. The pamphlet reiterates the old story about the " refuse rails" of the South Carolina railway, which has been positively contradicted by our correspondent " Q," in whose statements every confidence may be placed.

There is quite enough of the " incendiary" spirit in both of these rivals for the coal trade. If the capital of the railway be eight millions of dollars, then will it require 1,280,000 tons, netting 50 cents per ton, to pay the moderate interest of 8 per cent. The Schuylkill and other works will of course continue their contributions, and thus in order to make the Reading railway a successful work the consumption must be doubled at once.

The tolls on the Schuylkill canal are now 36 cents per ton, or 3 mills per ton per mile ; the capital is about $3\frac{1}{2}$ millions of dollars. To pay 8 per cent. on this sum, will require about 700,000 tons of coal per annum, exclusive of other sources of income. The Schuylkill canal carried last year 447,058 tons of coal, and " Examiner" estimates " the coal business of the Schuylkill field in 1844" at 800,000 tons. (p. 60). This is little more than enough for the canal, and only two-thirds of the quantity required by the railroad.

The pamphlet of the Baltimore and Ohio railroad company, published in this Journal, gives detailed estimates of the cost of transporting coal ; the aggregate of all expenses being very nearly $9\frac{1}{4}$ mills per ton per mile, exclusive of interest. They show that $1\frac{1}{4}$ cent per ton per mile will yield a fair profit.

On the other hand, " Examiner," (p. 51) makes the following estimate for the Reading railway, per ton per mile, descending, including taking back the empty cars.

Locomotive power,		·439
Maintenance of way,		·662
Maintenance of cars,		·448
Miscellaneous charges,		·200
	Total in cents,	1·739

This is very nearly twice the estimate of the Baltimore and Ohio company, endorsed by Mr. Latrobe. As time will shortly demonstrate which is the more reasonable view, further speculation is at this time useless, and we shall dismiss the subject after drawing attention to the following circumstance. In 1841 the Schuylkill canal brought down 584,000 tons, in 1843 only 447,058 tons which with the 229,015 tons per railroad, gives 676,073 tons from the "Schuylkill field" for that year. The railway was not doing enough to have any influence on the trade till last fall, yet the receipts of the canal fell from $575,000 in 1841 to $315,000 in 1842. The full price might have been maintained till late in 1843, and it looks very much as if the canal company to prevent the completion of the railway had literally thrown away nearly half a million of dollars, which would have paid dividends for 1842 and 1843, and left the company in a better state to compete with the railway. Had those entrusted with the direction of these works been actuated by the proper spirit, there could have been no difficulty in making an arrangement which would have yielded a fair profit to both. However much the public may appear to gain from the sacrifices made to injure each other, it entertains no other feeling than contempt for those who thus squander large sums confided to them by others for the purpose of securing fair dividends from undertakings calculated to advance the prosperity of the country.

In a late number, the statement of the Delaware and Hudson canal company for 1842 was given, and we now give the statement of this flourishing work for 1843.

Statement of the business of the Delaware and Hudson Canal Co. for 1843.

To coal on hand, March 1, 1843,	$124,691 50	By sales of coal,	$604,900 74
" Mining coal,	107,642 93	" Canal and railroad tolls,	30,996 53
" Railroad transportation and repairs,	103,808 02	" Interest received,	23,251 41
" Freight of coal to Rondout,	233,837 68	" Coal on hand,	71,054 25
" Canal repairs and superintendance,	77,700 23		
" Labor and expenses at Rondout,	21,219 50		
" Interest on State stock,	38,325 00		
" Interest on company loan,	2,349 00		
" Rents, salaries, current expenses, etc,	23,927 33		
Balance,	196,701 74		
	$930,302 93		$930,302 93
New York, March 1, 1844.		By balance,	$196,701 74

Hence it will be seen that the cost of transportation on the 108 miles of canal was $233,837, or 9½ mills per ton per mile, and the total cost from the mines, 126 miles, was 14½ mills per ton per mile. Deducting mining, interest, rents, etc., and the total charge may be taken at $2 80 per ton, or $·0222, or nearly 2¼ cents per ton per mile. The dividend amounts to 87½ cents per ton, about 7 mills per ton per mile, or more than twice the gross charges of the Schuylkill canal!

Lastly, it must be remembered that the railway, though only 16 miles

long, does one fourth of the work. The coal is mined on the west side of the mountains, and carried over the summit to the canal on the eastern slope, so that though only one-eighth of the entire line, it has to bear the brunt of the fight. In fact this work could scarcely exist without the railway, though we believe that the Schuylkill canal is not equally dependent on that mode of transportation.

The high rates of transportation—as compared with Philadelphia estimates—which coal affords on the works of the Delaware and Hudson canal company, show that that canal has peculiar advantages. The grand, the vital advantage is, that the work is complete in itself. The company owns from the mines to the Hudson, and can now deliver coal at tide water on that river as cheaply as it can be delivered in Philadelphia, if the *Miners' Journal* is correct in stating that the average cost of coal delivered in the cars or boats at Pottsville is, on an average, $2 25 per ton. We believe that no red-ash coal can be reached by any cheaper route than via the Delaware and Raritan canal, though the white-ash of the Wyoming field delivered on the Hudson at $3 50 per ton, yields 10 per cent. to the Delaware and Hudson canal company. Hence we conclude that no inconsiderable part of the coal trade will be from the mines to the Hudson, though we have no idea that the present trade of Philadelphia, or of the Delaware and Hudson canal company, is to be diminished by new avenues skillfully projected, and destined to accommodate the increasing demand, and not merely for the purpose of supplanting a useful flourishing work.

DUTY ON RAILROAD IRON.

The Pottsville Miners' Journal has a long article on *the iron trade*, in which the policy of keeping up the present duty of $25 per ton on railroad iron is warmly advocated. It is said that this article can be produced here for $55 per ton—but where? Can it be delivered in New York or Boston for that price? It is too generally overlooked that railways are, in many instances, more important to the manufacturer than any tariff. The cost of transportation of the materials, ore, coal, lime and manufactured article, is one of the grand items, and many works now abandoned would be in flourishing operation if they had a cheap communication, open throughout the year with the sea board. The immense capital required for the manufacture of railway iron, the uncertainty of the demand, and the very low profit it can afford under this branch of the iron trade the least desirable of all to the American iron master, as well as the very last in which he should engage. By means of railways establish the iron trade in all its most profitable branches, and then, when no other iron is imported, impose any duty on railroad iron which may appear at that time judicious ; but do not now cripple the rising energies of this best friend of the farmer and manufacturer for the purpose of inducing enterprizing men to embark in the least profitable and most uncertain branch of the trade, while such enormous quantities of iron are imported for the common purposes of life.

THE SCREW PROPELLER—STEAM NAVIGATION.

At the last meeting of the Liverpool Polytechnic society, the president, John Grantham, Esq., E. C., in the course of his annual address, said, that finding he had but few observations to make on the state and prospects of the society—so even had been the tenor of its way through all the changing scenes of the times—he should introduce to their notice a topic of public interest, suited to the character of their meetings; the subject he alluded to was the present state of steam navigation. After some introductory observations, as to the failure of the science as a profitable mechanical speculation, he called their attention to the screw propeller, as a substitute for paddle wheels —an improvement which he had great hopes would do much to place steam navigation on a firmer foundation. Several short notices of the screw propeller had appeared in scientific publications, [See *Mining Journal* of the 28th October, for a detailed description, with diagram,] but they were very imperfect, and little could be gleaned from them. It had, however, been referred to more satisfactorily, in a paper written by Mr. Elijah Galloway, the patentee of paddle wheels, in an appendix to Tredgold's work on the steam engine. But the author had not formed a decided opinion on the question, and did not establish its superiority. The French claimed to be the original inventors of the screw propeller, and few would dispute with them the honor on this point—though they also claimed the steam engine, which was due to the English. The lecturer here referred to a French paper detailing the performances of the French war steamer *Napoleon*, which were certainly satisfactory; and next noticed a number of instances in which the screw had been employed, even from the year 1699. It was also tried by different parties in 1743 and 1763. In 1802, the *Doncaster* transport, which had been becalmed, was worked into harbor at Malta, at the rate of one and a half mile per hour, by eight men at a spell. She went seven leagues with a screw, and the parties seemed to have contemplated every kind of propeller since patented by others. In 1825, the screw was applied to a vessel in the Thames. In 1828, a patent was taken out for a screw by Mr. Chas. Cummerow. In 1832, M. Sauvage also applied it. In the same year, Mr. Woodcroft, of Manchester, took out his patent; in 1836, Mr. Smith his; and in 1838, Mr. Ericsson also obtained one. Cummerow's and Smith's were much alike. Mr. Grantham then explained the principle of the screw, or inclined plane, and its advantages over the paddle wheel, assuming for argument sake, that simply as a propeller, there was no preference to be given to either. He referred to cross sections of two vessels of the same dimensions, one with the paddles, and the other with the screw; also to longitudinal sections of the same. By pointing to this, he clearly showed the several advantages of screw vessels. There were several kinds of screw propellers, but the principle was the same in all—an inclined plane turned round a spindle, or cylinder. This he showed by wrapping a piece of paper in the form of a right angled triangle round a roller; and the hypothenuse, or slanting edge, of the paper, described the worm of the screw, which might be made of any pitch. And if a screw were made to revolve in a solid, by giving it one revolution, it would move forward or backward, a distance equal to the pitch. There might be several threads in the same screw, but although this constituted a difference in form, the principle remained unaltered. Mr. Smith's first experiments were made with a single thread, or incline, wound round an axis, making an entire revolution, and presenting to the eye, when looking in the direction of the axis, the form of a complete disk. Ericsson's and others consisted of a short portion of the screw, with many threads, or inclines, in some cases appearing to the eye,

when placed in the direction of the axis, as a complete disk. [He here described the number of blades on the screw, and how they were formed.] Woodcroft, who obtained his patent in 1832, adopted a slightly different system. Instead of the thread being uniform, and the incline the same at all points, he proposes an increasing pitch at the after end. His object would be understood by considering a fish's tail, more particularly that of the eel. In the evolutions made by its body and tail, they each continued to increase; and, consequently, the rapidity with which it struck the water increased also, and compensated for the loss of effect occasioned to the tail by the motion given to the water by the body. In like manner, by giving this constantly increasing angle to the screw, the same result would follow. This he, Mr. Grantham, conceived to be a very beautiful modification of the original screw propeller. The principle did not escape the attention of others; and it was to be regretted that it had not been tried earlier and made known. He had alluded to the plans of Messrs. Smith, Ericsson and Woodcroft, to the first two as being best known, and because he believed the award of superiority, was, by almost common consent, given to it. Mr. Smith was the originator of a company that built the Archimedes—a vessel that circumnavigated England, and performed other long voyages. She first drew public attention to the subject. Great credit was due to that spirited company, and to Mr. Smith, for these experiments, which were conducted on a liberal scale; but this was not the first vessel that had been propelled by a screw. Ericsson had previously done much, and displayed great originality of thought. The form of his propeller, although not the subject of this patent, had never yet been surpassed, and it required only the elongated pitch to make it the most efficient yet constructed. He, the lecturer, was influenced by this opinion, when recently called upon to construct the small vessel called the *Liverpool Screw*, which had been at work on the Mersey. He had taken care not to infringe any patent on the screw he adopted, and was surprised to find, on looking over the list, that these valuable plans have been overlooked. Several experiments had been made by Messrs. Brunel, Claxton and Guppy at Bristol, under the superintendance of the latter, upon various forms of screw in the Archimedes. In these some curious facts were observed, and it was then suggested that it was possible to propel a vessel faster by the screw, than the screw itself would have gone, had it worked in a solid medium. He at first conceived that there was an error in the calculations, but subsequent observation induced him to believe it possible to obtain such a result, and that all vessels having the screw in the dead wood, or run, have a tendency to go faster than the theoretical calculation would lead us to expect—though if this tendency were increased, it would be at a loss of power. He accounted for it by the manner in which water fell into the vacancy left as the vessel passed onward. A similar operation might be observed in watching the eddy formed by the pier of a bridge, in which case the body was stationary, and the water moved, but their relative positions were the same in both. The conclusion, therefore, was, that though the relative effect between the screw and the vessel appeared to be favorable, yet that being obtained at a great sacrifice of power, such a result might arise from defects in the form of the vessel, and was, therefore, no good indication, and that the utmost efficiency would be obtained, when the speed of the screw was from one-fifteenth to one-twentieth part greater than that of the vessel. The lecturer then noticed some of the most remarkable screw vessels that had yet appeared, and the forms of the propellers employed, and considered the difficulties that opposed the general introduction of the screw, and showed that some of the objections to it were groundless. He showed, by diagrams of two vessels of equal size,

that where paddle wheel vessels could not easily have any beams over the engine room, on the plane of the lower deck, as the engine, etc., rose to the deck above, beams might be introduced in screw vessels at that point, not only greatly strengthening the vessel where she most wanted it, but admiting of a clear range of saloons, or cabins, fore and aft, with little or no interruption.

A short, interesting discussion took place, in the course of which the chairman ably and convincingly replied to the questions propounded, on the supposed lateral pressure of the screw.—*Mining Journal.*

COST OF TRANSPORTATION ON RAILROADS.

The cost of transportation on railways is the most important engineering topic at this time before the public. Hence every circumstance in any way elucidating the subject, even in a very small degree, is worthy of attention. In 1843, the freight on the Western railroad was equal to 60,350 tons carried 156 miles, or 9,414,621 tons carried one mile, the average load being $47\frac{3}{4}$ tons per train, *nett.* The passenger trains ran 216,139 miles, the merchandize trains 197,603 miles, miscellaneous trains 27,866, in all 441,608 miles. The total cost was $283,826 43, or $64\frac{1}{4}$ cents per mile run. If we assume the cost of all the trains to be equal, this would give 1·34 cents per ton per mile with trains averaging about half the power of the engines, and overcoming grades of 84 feet per mile, at an average velocity of 15 miles per hour. With a speed of 8 miles per hour, and grades of from 35 to 40 feet per mile, twice the load would be taken without any additional expense than the loading, unloading and wear of cars, say 3 mills per ton per mile, making the total cost 96 mills per ton per mile, exclusive of renewal of track. If the engine can take 150 tons, all expenses including repairs and renewals would not exceed one cent per ton per mile, which is about the estimate of the Baltimore and Ohio railroad company as given in our last number. As the cost of the freight trains is not given separately, we have assumed the cost to be equal.

The receipts for merchandize were $275,606 19, or $4 57 per ton, or $·0299, say 3 cents per ton per mile, and this " exceeded the entire expense of conducting the business of the road." The total amount paid for transportation on the Erie canal is estimated at from $4\frac{1}{2}$ to 5 millions of dollars for carrying nearly 400,000 tons a distance of 363 miles. This gives very nearly 3 cents per ton (of 2000 pounds) per mile. Again, the statement of the Delaware and Hudson canal company gave $2\frac{3}{4}$ cents per ton per mile as the amount received in 1843. Could the Western railroad run with full trains at a low rate of speed, and be sure of 200,000 tons of freight per annum, it does appear to us that it could carry quite as cheaply as any canal in the State of New York, supposing both to yield not less than 8 per cent. on their capital. Where dividends are passed by, as on the public, and, we are sorry to say, on some of the private works of Pennsylvania, they can of course carry more cheaply than those who do not choose " to work for nothing and find themselves."

SPARK ARRESTER.

We have in our office a very neat model of Messrs. French and Baird's

Fig. 1.

patent " Spark Arrester." In the accompanying wood cut, (fig. 1,) is a vertical section through the axis, in which P is the smokepipe, from which the steam and the sparks pass through the " volutes" *v*, (figs. 1 and 2) into the chamber C, in the manner represented by the arrows. The centrifugal force generated by the "volutes," forces the sparks against the outer side of the chamber C, in which are numerous openings *o*, through which they fall down between the smokepipe and the outer casing. The steam escapes through the perforated plates *d*, which, from their arrangement present a very large surface for that object. The peculiarities of this arrangement are the application of the centrifugal force as above described, and the mode of increasing the surface of the wire-cloth, or perforated sheets of metal, without increasing the diameter of

Fig. 2.

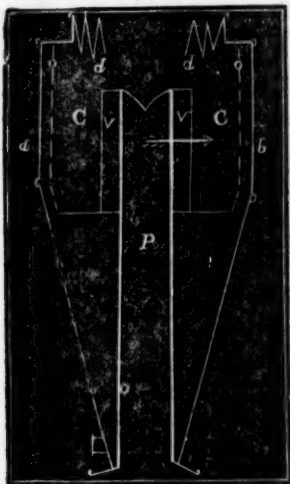the pipe, by means of joining the rings at their upper and lower edges alternately, as seen in fig. 1, *d*.

It has been in use for some time on the Georgia, Philadelphia, Germantown and Norristown, Wilmington and Baltimore, Lexington and Ohio railways, and we have seen flattering testimonials from the superintendants of all these works. The very best workmanship is indispensable; and experience has shown that certain parts require the material to be of peculiar strength and quality. When in perfect order, it has been stated to us, that, in running in the night, there is scarcely ever a spark to be seen.

The cut gives only a general idea of the " modus operandi," and numerous views and sections would be necessary to give a working plan. Messrs. French and Baird are established in Philadelphia.

RAILWAY COMMUNICATION THROUGH FRANCE.

We find in the April number of the " London Polytecnic Magazine and Journal of Science," the following article in relation to railways in France, by William Bridges.

On the 27th of December, 1841, after two years of legislative talk in the French chambers, in the course of which, sometimes the principle of leaving everything to private enterprize, sometimes the necessity of government con-

trol and supervision, sometimes the advantages of both methods was insisted on, discussed and negatived, the speech of the French king led France to expect that something would finally be done to put France, as respects railway communication, on a level with the rest of Europe. And it was full time ; Belgium had already completed 80 leagues ; Germany 180 ; England 1400 miles ; France nothing. And even in April, 1842, it is stated in part IV of the commercial tariffs and regulations, presented to the British parliament, that French railroad communication embraced a very bad line from St. Etienne to Lyons, one from Paris to St. Germain, and two from Paris to Versailles. In the royal speech referred to, several important lines were announced as under consideration ; among others, a line connecting Paris with Lille and Calais. It was fairly anticipated that such a line, forming a connecting link not only between Paris and London, but also between England and Belgium by way of Lille, and by means of the Belgian railways, with the Rhine, would be most valuable to English interests ; while another proposed to Lyons would facilitate the overland passage to the east, as this one to Berlin and the north of Europe.

A few months after the announcement by the king of the intention on the part of government to bring in a measure for the encouragement of railway undertakings, a bill was submitted, and after some discussion became law on the 11th of June, 1842. By this law it was resolved to establish a national system of railways, to unite France with Belgium, England, Germany, the Mediterranean and Spain ; and to give a stimulus to internal traffic. The mode proposed to give effect to these objects was one unsuitable, perhaps, to the English commercial spirit, but rendered absolutely necessary in France, from the difficulties which had been experienced, and the fearful jobbing which had taken place in the prosecution of the few private railway speculations which had been already entered into. The French government, seeing that hitherto a few great millionaires had engrossed every undertaking of this character, undertook now to provide the land, and execute all the earth works, tunnels, bridges, etc. ; the portion left to private enterprize being less precarious, extending only to the laying on of the ballast, the formation of the permanent way, with the supply of locomotive power, carriages and *material* for working. The valuation of all lands for which compensation was required was to be left to a jury ; a most wise regulation, and one which this country would do well to imitate. One-third of this compensation was to be borne by the State, the remainder by the departments and parishes whose interests were affected by the line.

Under this law a very important line has been completed to Rouen, and is now in further progress towards Havre ; so that we may speedily expect to be put within a twelve hours' journey to Paris. We perceive now that an extension of the line eastward is in contemplation, to the very banks of the Rhine, to connect London, Havre, Paris and Strasburg ; and as the last of these cities forming the terminus of a direct line across the richest and most industrious districts of France, is also the intended point of convergence for all the national railroads of Germany, the national and international benefits of such a line can hardly be over estimated. The distance from Havre to Paris is 144 miles, from Paris to Strasburg 286 miles, almost exactly double ; the aggregate length of the journey is therefore 430 miles, one *railway hour* further than from London to Edinburgh. To traverse this route under present means of intercommunication, to transport the wines and grain and innumerable herds of La Brie and the Moselle, or the produce of the growing factories of Alsace, the continental Lancashire, between and among the various towns and cities of Paris and Strasburg, Chateau

Thierry, Nancy and the valleys of the Marne and the Saverne, is a work, which, to the Englishman, accustomed to the comfort and expedition of his Great Westerns and Midland Counties, and other railway facilities, would be appalling enough, considering that the actual traffic extends to upwards of 100,000 French tons per annum, and an aggregate of 200,000 passengers via Strasburg to and from the Germanic provinces.

The country, commencing at the Strasburg end of this great "thoroughfare," is the continental United States—the provinces of Zollverein, containing nearly 30,000,000 of inhabitants, and nearly 200,000 square miles of fertile territory. The high duties of that league—or rather its vexatious and unequal duties—that on cotton alone varying from 3 to 120 per cent. on the value, being levied on the same principle as that upon tea in England, favoring the rich at the expense of the poorer classes, taken in conjunction with our restrictive commercial policy, have had the effect of unduly diverting capital in an agricultural country to commercial and manufacturing enterprize; the factories of Baden, now 300 in number, more than doubled in the course of seven or eight years, while the Saxon spinning establishments and stocking frames advanced more rapidly in three years towards 1840, than in thirty years previous. Seeing that England now sends 100,000 cwts. of cotton wool to this wool growing country, we may be convinced that there is something "rotten in the State of Denmark," which, perhaps, is to be corrected more by such facilitation of social intercourse as we here discuss, than by a modification of our tariffs. At the Leipsic fair, at least, we know that the market is inundated with smuggled English manufactures. A new facility to smuggling will lead to such measures of policy as will substitute honest and open national traffic for contraband dealing. It is in this manner that the healthy interchange of the agricultural products of France and Germany and the manufactures of England will alone be restored; or if it is now too late to look to the German States for a market for our cottons and calicos, let us even, if we can transport nothing else, be glad to find a ready and ever open conveyance for our machinery to supply the looms of Alsace, and the spinning establishments of Prussia.

SHIP CANAL.

Through the politeness of Col. Abert, of the bureau of topographical engineers, Washington, who will please accept our thanks, we have received several reports; and, among others, one in relation to the construction of a ship canal around the falls of St. Mary, in Michigan, which we give entire, except the map.

Report of the secretary of war, communicating an estimate of the cost of constructing a ship canal round the falls of St. Mary.

War Department, Jan. 4, 1844.

SIR: In pursuance of the resolution of the Senate passed on the 27th ult., I transmit, herewith, a report from the bureau of topographical engineers, with an estimate of the cost of connecting lakes Huron and Superior by means of a canal round the falls of St. Mary, adapted to navigation by steam vessels.

As the resolution calls for any estimates of the cost of this work in the possession of the department, the colonel of the corps of topographical engineers has given the plan and estimate of Mr. Almy, made in 1837, for the description of canal therein contemplated. But, deeming the resolution to look to a canal of larger dimensions, he has added his own plan and estimate

for a canal "adapted to navigation by steam vessels," based on the best information which he could obtain in relation to the subject.

Very respectfully, your obedient servant,

J. M. PORTER.

Hon. W. P. MANGUM, *President of the Senate.*

Bureau of Topographical Engineers.
Washington. Jan. 3, 1844.

SIR: In obedience to your direction, I have the honor to submit an estimate for a canal, "connecting lake Huron and lake Superior, adapted to navigation by steam vessels," called for by a resolution of the Senate of the 27th instant.

As there has never been a survey of that locality for such a purpose by this office, I am without those elements for an estimate upon which the office usually relies.

In the absence of such information, resort has been had to a survey made by Mr. J. Almy, in 1837. Mr. Almy was an engineer in the employ of the State of Michigan. Also, in anticipation that information of the kind now called for would probably be required during the present session, a letter was addressed to Capt. Johnston, at Fort Brady, in July last, proposing certain queries having reference to this canal, which he was desired to have investigated and answered. His answer of last September is hereto annexed, together with the information asked for, which was collected with much care by Lieut. Handy, of the 5th infantry.

This information, together with the survey of Mr. Almy, will enable me to submit an estimate upon which reliance may be placed.

Mr. Almy's survey, report and estimate are hereto annexed. His estimate amounts to $112,544, which would probably be sufficient for the construction of a canal of the kind and dimensions contemplated in his report.

But the resolution of the Senate contemplates a canal "adapted to navigation by steam vessels." A canal for such a purpose involves considerations that will much enhance the cost beyond the estimate of Mr. Almy. The government steamer, Michigan is 167 feet long, 47 feet wide, draws 8 feet water, and is of 600 tons burden. Freight vessels of these dimensions would draw more water, as they are generally more heavily laden; and, from the best information I have been able to collect, a draught of ten feet is the least which can with safety be adopted for the largest class of lake steamers. Nor can less than two feet of water below the bottom of the boat be adopted for the canal. These dimensions give data for the size of the canal and of the locks, viz: for the canal, 100 feet wide and 12 feet deep; for the locks, 200 feet long and 50 feet wide.

The difference of level (according to the survey) between lake Superior and lake Huron is about 21 feet, which is supposed to divide into three lifts. The locks should be collected together at the lower end, in steps, without intervening basins, as exhibited in red lines upon the plan, and should be in double sets; one set for the ascending and one for the descending trade. The towing path to be three feet above the water line, and where this path is upon the embankment it should be twelve feet wide; the berm upon the opposite side to be six feet wide; the canal to be without lateral slope, but to have the same width, except as to batter of side walls, at bottom as at the water surface; the sides of the canal to be maintained or reveted with dry stone walls. The dry masonry of these walls to be three feet wide at top, and five feet wide at bottom; but where the excavation exhibits a sufficiently firm rock facing, these dimensions may be reduced. The extension of the

work into lake Superior will have to be about 800 feet, before a sufficient depth is obtained, and there will probably have to be some excavation under water at the lower end of the canal, although the profile of Mr. Almy does not exhibit its necessity.

The total length of the canal line from water to water, exclusive of the extension of work into the lake, is about 4,400 feet, throughout a part of which an embankment will have to be raised, as exhibited in the profile. A pier to protect the entrance, of the canal, supplied with belaying posts, will have to be extended for about 800 feet into lake Superior, upon the southern side of the canal.

As lake Superior has, from various causes, a difference in its level of about four feet, it will be necessary to construct a guard lock at the junction of the canal with that lake; and, also, in order that the water may be occasionally shut off for purposes of cleaning and repairing the canal. And in consequence of variations of level in the water below the falls, the last set of locks in the series at the lower end of the canal may have in their construction to embrace the considerations due to lift and guard locks.

The prices for the excavation are taken from Mr. Almy's estimate; those for the embankment and dry walling from data in this office; those for the locks from a report of Capt. Williams for a canal to overcome the falls at Niagara, as it is not supposed that works of this kind can be done for less at St. Mary's than at Niagara.

The difference between the estimates (that of Mr. Almy and that now submitted) arises principally from differences of dimensions in the two plans, and from those considerations which belong to a canal adapted to steam navigation, and to the active trade which the canal will have to accommodate.

In works of this kind we should avoid the mistake committed at Louisville, which already, in the judgment of so many, renders the construction of a second canal at that locality necessary.

The cost of constructing this canal would be very much reduced if the U. States troops were employed upon it. A detachment of about five hundred men would accomplish the object by the usual roster details, and the difference of cost would be in the difference between the usual price of labor, and the allowance of 15 cents per day to the soldier when so employed. The employment of the army upon such works, in times of peace, is customary with all other nations, and I can see no sound objection to the adoption of the practice in our service. Such occupation is no injury to the discipline, while it preserves the bodily health and mental vigor of the men, and increases their efficiency and usefulness for their ordinary duties. These considerations are, however, not involved in the estimate.

ESTIMATE.

Guard lock at lake Superior, - - -	$27,897 00
For cutting 18,500 cubic yards of rock under water, at $1 50 per yard,	27,750 00
For cutting 89,920 cubic yards of rock, at $1 per yard, -	89,920 00
For excavating 8,647 cubic yards of sandy loam and vegetable mould on top of the rock, at 20 cents per yard, - - -	1,729 40
Do. do. 113,607 c. yds. loam, gravel, vegetable mould, etc., at 25 cts. per yd.,	28,401 75
For embanking 15,600 cubic yards, at 12 cents per yard, -	1,872 00
For 11,555 cubic yards of dry masonry wall, at $2 per yard, -	23,110 00
For three double locks, at $66,715 each, - - -	200,145 00
For a pier 800 feet long and 12 feet wide, - - - -	12,000 00
Contingencies, 10 per cent., - - - - -	41,282 51
Total, - - - - -	454,107 66

Respectfully submitted by, sir, your ob't. serv't,   J. J. ABERT,
Col. Corps Topographical Engineers.

Hon. J. M. PORTER, *Secretary of War.*

Fort Brady, Michigan, Sept. 29, 1843.

Sir: I have the honor to enclose, herewith, answers to your queries of July 25th.

The necessary examinations have been made by Lieutenant Handy, 5th infantry.

As far as I can judge, having been over part of the ground, and from reports of others, I think he is as correct as he assumes to be; wanting, as he mentions, instruments necessary to exactness.

Permit me to add, that Lieut. Handy, besides willingly undertaking this duty, has, I think, shown both diligence and skill in the performance of it.

I am, sir, with respect, your obedient servant,   A. JOHNSTON,

Capt. 5th Infantry, commanding Fort Brady.

Col. ABERT, *Chief Topographical Engineer, Washington.*

Fort Brady, Michigan, Sept. 8, 1843.

Sir: In conformity with instructions contained in your letter of July 25th, requesting information in reference to the practicability of a canal route in the vicinity of the Saut de Ste. Marie, Michigan, I have the honor to lay before you the result of my observations, having been detailed for this duty by Capt. Johnston, commanding Fort Brady. You desire to know,

1st. "What kind of soil does the projected canal pass over?"

From the upper or western extremity of the canal line to the mill race, (a distance equal to about half of its length,) the soil consists of vegetable mould, underlaid by a bed of red sandstone rock, of a very soft nature, and very thinly stratified—the strata, in many instances, not exceeding an inch in thickness. The adhesion between the strata, in many places along the canal line, is so slight that they can be easily removed with the hand. From the mill race to the lower or eastern extremity of the line, the soil consists generally of sand and loam, interspersed with boulders of granite, gneiss, etc., varying in size from two to four feet diameter. Most of these boulders are of a very good material for building, and would be serviceable in the construction of locks, etc. In many places along the line, the soil is of a very permeable nature, so much so, that upon breaking ground, the water makes rapidly.

2d. "Is the rock near the surface, or what distance from the surface, generally, in the extent of the line?"

The average depth of the rock below the surface, for the distance above mentioned, is about one foot. In some places, it is only six inches; in others, more than five feet below it—the strata dipping in a direction parallel to the line of the canal.

3d. "What is the depth of the water near the shore, at each end of the canal line, and what distance from the shore before a depth of fifteen feet is attained?"

The average depth of water at the lower end of the line, for a distance of about 60 feet from the shore, is 2½ feet, when it suddenly deepens to 6 or 8 feet. The shortest distance from the shore at which a depth of 15 feet is attained, is 52 yards. At the upper end of the line, the average depth of water is from 2½ to 4 feet. To attain a depth of 15 feet, it is necessary to go about 226 yards from the shore, in a line forming an angle of about forty degrees with the canal line. Following the direct line of the canal, it would be necessary to proceed up the river several miles before a depth of 15 feet could be attained, for the water continues at a uniform depth of about one fathom for a very considerable distance along the American side of the river, so that it is necessary to proceed out some distance in a direction at right angles with

the line of the shore to strike the channel. Upon reaching the channel, the water suddenly deepens to several fathoms; the bed of the river, at this point, sloping off very abruptly, at an angle of about 30 degrees.

5th. " Is the bottom at both ends mud or rock?"

The bottom at the lower end of the line consists generally of sand, underlaid by a stratum of hard clay, with here and there a bed of sandstone rock of trifling extent.

At the upper end the bottom consists of an extended bed of sandstone rock; being a continuation of the bed before described as underlaying the canal line for about half of its extent. This rock extends to a distance of several hundred feet from the shore, and is overlaid by a stratum of sand, averaging about one foot and a half in thickness.

6th. " Are there any shoal places below Fort Brady sufficient to obstruct first class lake steamers, in a passage up to near the lower end of the canal?"

About 20 miles below Fort Brady, at a widening of the river known as lake George, there is a bar of very hard clay, underlaid by a substance resembling quicksand in its properties. As this bar extends completely across the lake, all vessels navigating the river are compelled to pass over it. The depth of water upon it is very variable; sometimes exceeding nine feet, and sometimes, though rarely, not exceeding six. The average depth may be laid down at seven feet. It has frequently been crossed by the largest class of steamers at present navigating the lakes. This is the only obstruction of importance between Fort Brady and the mouth of the river, though the channel is very winding, rendering the navigation rather intricate.

It would perhaps be as well to state that the water in the St. Mary's river is much higher at some seasons than at others; and it is at present higher, by upwards of two feet, than it has been for some years past. In ascertaining the distance to which it is necessary to go from each end of the canal for a depth of fifteen feet, I have therefore made some allowance for this unusual rise of the water.

I would also remark, that owing to a want of proper instruments, my observations, respecting distances, etc., are not made with that accuracy with which I should otherwise have been enabled to make them; but I trust they will prove sufficiently accurate for all practical purposes.

I have the honor to be, very respct.'y, your ob't serv't,   J. O. HANDY,

Brevet 2d Lieut. 5th Infantry.

Col. J. J. ABERT, *Chief of the Topographical Bureau.*

September, 1837.

SIR: In pursuance of my appointment from you as engineer, and in pursuance of an act of the legislature, I have the honor to transmit, herewith, the survey and estimate of the expense of constructing a ship canal around the falls of St. Mary; also, maps and profiles showing the location of the proposed line of canal, together with the depth, quantity and quality of the excavation.

Having had the honor of being one of a special committee to whom was submitted for consideration, at the last session of the legislature, the project of uniting the water of lake Superior with lake Huron by a ship canal, and having been also identified with all the subsequent proceedings as the friend and advocate of the proposed work, yet I hope that neither of these circumstances has had any influence with me in making up and presenting a more favorable report than is warranted from a careful survey and examination of the proposed line of communication.

I do not deem it necessary, before entering into a topographical description

of the country in the immediate vicinity of the proposed improvement, although it might not be out of place, neither is there required at the hands of the engineer, any speculations or statements in regard to what would be the effect on commercial operations by removing the barrier to navigation between lakes Huron and Superior.

If, however, any information on this subject should be deemed indispensable, there are sources from which, I apprehend, the most convincing and satisfactory evidence can be obtained of the importance and utility of the work in question.

By reference to the map and profile of the canal proposed, it will be perceived that no difficulties of a serious nature interpose or are to be apprehended in the event of its construction. Even that portion of the line where rock is indicated will not, owing to its peculiar quality and position, require blasting.

The total length of the proposed canal, from the deep water at the head of the falls to its termination at the foot, is 4,560 feet; and the portion which may be estimated the most difficult and expensive to excavate, embraces a distance of about 700 feet, from the head of the canal to the deep water in the river; yet, in the excavation of this part of the work, no very extraordinary expense will be involved.

As the project under contemplation comprehends a ship canal, it becomes necessary to define the capacity and dimensions and proportions of both canal and locks, as I believe will accommodate the larger class of sail vessels now used on any of our lakes, and for whose accommodation and use I make no doubt this work was originally designed and projected. I would, however, remark that the only part of the work where the expense would be increased by constructing the same to accommodate the largest class of steamboats, will consist in the increased magnitude of the locks, which, on investigation, will be found no small item.

The dimensions of the canal and locks, and upon which the dimensions have been based, are as follows: all that portion of the line where the profile indicates rock, I propose to execute by a cut affording a width of 75 feet on the surface of the water, with 10 feet depth, giving the side a slope corresponding to a bottom of 50 feet. The residue of the canal, not occupied by the locks, will have a width on the surface of the water of 100 feet.

To the locks I propose to give the following dimensions and proportions, viz: 100 feet in the clear for length, and 32 feet for width; and as the whole amount of fall to be overcome by lockage is 18 feet, I have deemed it prudent, on the ground of avoiding great hydraulic pressure on the side walls and gates, to divide the same into three lifts of six feet each.

In regard to the facilities afforded for the construction of such parts of the works as may require the use of stone, I would remark that nature seems to have left no room for complaint. The surface of the ground immediately on a line with the proposed work, and where it becomes necessary to locate the locks, is covered with large detached masses of granite, of sufficient magnitude for lock stone. And we shall duly appreciate the advantages and conveniences of having this material so near at hand, when we take into consideration the great expense of fitting and transporting this indispensable article, so necessary for the permanent and durable construction of such works, from quarries remote from the place where the same is required to be used.

With these remarks, I submit the following estimate of expense of constructing the said canal:

ESTIMATE.

Excavating 8,750 cubic yards of rock under water, between station No. 1, and deep water in river, (see profile) being a distance of about 700 feet, at $1 50 per yard, - $13,125 00
(This rock is red sandstone, lying in strata from two to four inches thick, easily separated.)

Excavating 23,709 cubic yards of rock of the same quality as above, embracing a distance of 1,300 feet, from station No. 1 to 13, (see profile) at $1 per yard, -   -   -   23,709 00

Excavating 8,589 cubic yards of earth, consisting of sandy lime and muck on the top of the rocks, between stations No. 1 and 13, at 20 cents,   -   -   -   -   1,717 80

Excavating 28,802 cubic yards, consisting of loam, gravel and muck, from station No. 13 to 29, at 25 cents, -   -   7,200 50

Excavating 21,442 cubic yards of excavation for locks, (quality of earth, as above,) at 25 cents,   -   -   -   5,360 50
   $51,112 80

ESTIMATE FOR LOCKS. (See map and profile for its location.)

Lock No. 1.		Lock No. 3.	
1,322 yards of stone masonry, in water cement, at $5 50,	$7,271 00	1,322 c. yds. of stone masonry in water cement, at $5 50,	$7,271 00
68 feet of quarry stone at $8,	544 00	76 ft. quarry stone, at $8 per ft.,	608 00
Gates and iron,	1,500 00	Gates and iron,	1,500 00
Foundation for locks, sills, etc.,	1,200 00	Foundation for locks, sills, etc.,	1,200 00
3000 yds. embankment, at 25 cts.,	750 00	Coping stone, etc.,	800 00
Coping stone and incidental work,	800 00	200 yds. of stone masonry, wing	
Contingencies,	1,200 00	walls, etc., at $5 50,	1,100 00
	$13,265 00	Estimated expense of coffer dam and pumping out pit,	1,500 00
Lock No. 2.		Contingencies,	1,397 00
1,322 c. yds. of stone masonry, in water cement, at $5 50,	$7,271 00		15,376 00
68 feet of quarry stone, at $8,	544 00		
Gates and iron,	1,500 00	RECAPITULATION.	
Foundation for locks, mitres, etc.,	1,200 00	Cost of rock and earth excavation,	51,112 80
3000 c. yds. embankment, at 25 cts.,	750 00		
Coping stone, etc.,	800 00	Cost of lock No. 1,	13,265 00
Pumping and keeping lock pit free from water,	1,500 00	Cost of lock No. 2,	14,915 00
		Cost of lock No. 3,	15,376 00
Contingencies,	1,350 00	Contingencies,	9,376 00
	14,915 00		104,044 80

In order to include every possible item of expense, I have thought proper to add a further estimate for a pier and guard gate at the head of the canal although I do not deem them absolutely necessary, and which are estimated as follows:

Laying down and filling 700 feet of pier,   -   -   -   -   -   6,500 00
Guard gates,   -   -   -   -   -   -   -   -   -   2,000 00
   8,500 00

This amount, added to the above, will make the sum total of $112,544 80. as the cost of constructing the proposed canal.

The above is respectfully submitted by your obedient servant,

J. ALMY, *Civil Engineer.*

His Excellency STEVENS T. MASON,
     Governor of the State of Michigan.

True copy: A. CANFIELD, *Capt. Top. Engineers.*

RAILROAD RECEIPTS.

We find in the Journal of Commerce the following comparative statement of the receipts for four months on the Utica and Schenectady, Syracuse and Utica, and New York and Erie railroads. The result is highly satisfactory —showing, as it does, the regular and certain increase of business, and, of course, the extension of the railroad system.

NEW YORK AND ERIE RAILROAD.

The earnings on this road during the month of April, 1844, were

From freight,	$6,612 77
From milk,	2,166 87
From passengers and mail,	5,075 41
	$13,855 05

The earnings for the same period last year, since when the road has been extended seven miles, were,

8,946 62

4,908 43

SYRACUSE AND UTICA RAILROAD.

Comparative receipts for four months.

	1843.	1844.
January,	$4,910 43	$5,169 39
February,	4,093 05	5,259 50
March,	4,203 64	7,384 83
April,	10,166 77	19,372 99
	$23,373 87	$37,186 71

UTICA AND SCHENECTADY.

January to May, 1843,		$46,108 47
do. do. 1844,		59,763 83
Gain of		$13,655 36

MISCELLANEOUS NOTICES.

Large quantities of up-freight remained at Albany early in May waiting for boats, though by the end of the month they will scarcely be half employed. The late opening of the Erie canal is becoming every year more injurious to the State and city, and the branches of Philadelphia forwarding houses are consequently very numerous here. It is scarcely necessary to say that this difficulty cannot be in any way affected by the enlargement— it is the want of boats, not of capacity of canal, which keeps these goods back, and if larger boats were used, there would of course be fewer of them. The spring trade—if free—would commence early in March; now it is delayed to the end of April, via the Erie canal, all the early freight going via Philadelphia, when its destination can be reached by that route, the additional cost of transportation being a small item on merchandize.

The legislature of N. York has at last granted permission to the people to transport freight on the railways between Albany and Buffalo during the suspension of navigation on the Erie canal, but paying canal tolls. By this ingenious arrangement the public will receive the smallest accommodation with the highest charges, and the railway companies can expect but a trifling return from the large additional capital invested, and the greatly increased incidental expenses. If the companies will only unite to give the farmers the greatest facilities, and be well prepared to get hold of as much merchandize as possible before the opening of the canal, the result can be neither distant nor doubtful.

The *Tonawanda railroad company* are about rebuilding their road. In 1837 one of our correspondents undertook to demonstrate that the construction of this road was such as to give the least possible strength with a given quantity of material. The projector, in answer, attempted to show that the effect was a maximum, and the communication was accompanied by drawings which placed the new mode—the "block" system—fairly before the readers of the *Journal.*

DR. FRANKLIN ON ENGINEERING.—*August,* 1772.

"I am glad my canal papers were agreeable to you. If any work of that kind is set on foot in America, I think it would be saving money to engage, by a handsome salary, an engineer from here, who has been accustomed to such business. The many canals on foot here, under different great masters, are daily raising a number of pupils in the art, some of whom may want employment hereafter ; and a single mistake through inexperience, in such important works, may cost much more than the expense of salary to an ingenious young man already well acquainted with both principles and practice. This the Irish have learnt at a dear rate, in the first attempt of their great canal, and now are endeavoring to get Smeaton to come and rectify their errors. With regard to your question, whether it is best to make the Schuylkill a part of the navigation to the back country, or whether the difficulty of that river, subject to all the inconveniences of floods, ice, etc., will not be greater than the expense of digging, locks, etc., I can only say, that here they look on the constant practicability of a navigation, allowing boats to pass and repass at all times and season , without hindrance, to be a point of the greatest importance ; and, therefore, they seldom, or never, use a river where it can be avoided. Locks in rivers are subject to many more accidents than those in still water canals ; and the carrying away a few locks by freshets, or ice, not only creates a great expense, but interrupts business for a long time, till repairs are made, which may soon be destroyed again ; and thus the carrying on a course of business, by such a navigation, be discouraged, as subject to frequent interruptions ; the toll, too, must be higher to pay for such repairs. Rivers are ungovernable things, especially in hilly countries ; canals are quiet, and very manageable : therefore they are often carried on here by the sides of rivers, only on ground above the reach of floods, no other use being made of the rivers than to supply, occasionally, the waste of water in the canals."

Very serious riots occurred in Montreal, owing to the canal laborers taking possession of the polls. We regret these occurrences, as they in some degree throw odium on public works in general. At the same time, however, it is proper to state that they were engaged on government works, that they turned out to support the projectors of these works, and succeeded. All have been since "discharged," and—*re-engaged*, with few exceptions. They are of course ready for the next election. It is difficult to speak of such atrocious occurences in a Journal devoted to the advancement of civil engineering, though nothing can be more hostile to the cause to which our labors are devoted.

The *Louisville, Cincinnati and Charleston railroad company* state, in their report of 29th November, 1843, that in consequence of a diminution in charges, "the quantity transported within the same period has been quadrupled, and, in some instances, tenfold.,"

"Under the new reduced rates, bricks, lumber, wood, and even coal and ice, with most of the articles of domestic produce, hitherto prohibited under the higher rates charged, are becoming important items on the freight lists ; and promise, in the future, to greatly augment the profits on the road."

They have added to their stock "three of Baldwin and Whitney's new improved six wheel connected engines. These locomotives, thus far, have fulfilled their promise, not only in the greater power exerted, but in the facility with which they pass the curves ; and the little injury, compared with engines of the smallest class, they inflict on the road. Those in possession of our company though of a weight not exceeding 11 1-2 tons, have

been found fully equal to the transportation of 1000 bales of cotton ; and on an emergency, with the eight wheel platform cars composing their train, each might be made to haul from 12 to 1500 bales of cotton."

They point out also the vast advantages which would result from a connection with the Georgia railroad, realizing all that was anticipated, and far more than could have resulted from the route to Cincinnati, and that, too, with a comparatively small expenditure. They state one—to a friend of railways—distressing fact.

" The most imposing obstructions are still at our own door, in the interval between our depot on the neck, and the wharves in Charleston, and in the expense of the dray charges from one to the other, amounting, in many instances, to 40 per cent. on the railroad freight, on the entire distance from Charleston to Hamburg, and to Columbia !"

The *Baltimore and Susquehanna railroad company*, in their report of December, 1843, refer to new cars invented and patented by their machinist, Mr. J. Millholland.

" Each of these cars has six wheels, weighs in all about 8500 lbs., and will carry 12000 to 14000 lbs. of most descriptions of produce, the full load of an ordinary eight wheeled car. Their cost, averaging less than $450 each, is considerably below that of cars of equal quality with eight wheels."

" During the year, a purchase was made from the patentees, of the right to use what appears to be the most effectual invention which has yet been made, for preventing fires from the escape of sparks from the locomotives." * * " It has now been used for two years and a half, and since its adoption no instance has occurred of fire being communicated by sparks from the locomotives of the company. The cost of this purchase was $2000."

The name of the inventor is not given. Wood is the fuel used on this road. They complain of the late period at which the canals of Pennsylvania open: what would they say of the Erie canal?

" It is to be remarked that the Pittsburg trade over this route was not so great as it would otherwise have been, in consequence of the unusual length of time during which the Pennsylvania canals were closed last winter by the ice. In the year 1841, they were not closed until the 20th of December, and were opened on the 7th of March following, while in the ensuing fall they were closed on the 25th of November, 1842, and were not opened until the 7th of April last. There is good reason for believing that a considerable amount of produce and merchandize was in consequence diverted from this to other routes."

A route has been surveyed for a " *Northern Railroad*" from Concord to Lebanon, N.H., and a report made by Mr. T. J. Carter, engineer, who estimates the cost for a single track at $20,000 per mile, with heavy, rail, cars, engines, etc. The distance is 70 miles ; 25·45 miles are level ; 15·75 miles are on gradients of 52·80 feet per mile; the remaining distance consists of short planes of from 4 to 47 feet per mile. A good map and profile accompany and illustrate the report.

Hunt's Merchant's Magazine, for May, contains a paper, by W. Beach Lawrence, Esq., of this city, on the *Croton Aqueduct.* He regrets the departure from the plan of Major Douglass "in crossing the Harlem river and Manhattan valley, both of which alterations detract greatly from the magnificence, if not from the utility of the work," (p. 437.) Mr. Lawrence appears to have overlooked the late "dam," which a frequent contributor to our pages has denounced in no measured terms. The dam has been rebuilt, and has four times the capacity of the old dam. To the great cost of construction must be added the damages caused by its giving way, to the amount of about $100,000.

The following remarks of Mr. Lawrence apply with force to only too many of our great public works:

"Unfortunately, owing to collisions between the chief engineer and the commissioners to whom, according to the system prevalent in this country, the superintendence of the work was confided, and who, as is ordinarily the case, whether the enterprize is of a public or a private nature, were selected without reference to scientific qualifications, Major Douglass was, at an early day, obliged to discontinue his connection with the aqueduct, and his successor, educated in a wholly different school, however competent to the mechanical execution of the work, had none of the enlarged views which influenced the engineer with whom the plan originated."

The *Outlet at Black's Eddy* has at length been authorized. This work will ultimately be of importance to the coal trade of Pennsylvania with this city and the north and east generally. It has been strenuously opposed by those interested in the Schuylkill region, and with success till now.

An additional tax has been imposed to meet the liabilities of the canals of New York, to the amount of the interest of the loan authorized, 1,200,000 dollars.

Railway Extension.—The central railway, Michigan, has been extended ten miles to Gridley's station; to which place the cars now run.

Patents—Annual Report of the Commissioner.—We are indebted to C. M. Keller, Esq., of the patent office, for a copy of the report of the commissioner, to which we shall refer more particularly in our next number.

FOREIGN PERIODICALS FOR MAY.

By the Brittania, we have received the *Civil Engineer and Architects' Journal*, and the *London Polytecnic Magazine*, for May; but the number for June is so nearly in type that we have only room for a few extracts from the former.

There is, in this number of the Polytecnic Magazine, Part II of "railway communication through France," which treats of the "metallization of wood," and also a description of the "inclined railway into Liege," which will be given in our next.

Institute of Civil Engineers.—The discussion on the subject of slips in cuttings and embankments of railways was renewed, and extended to such a length as to prevent any papers from being read. Some observations were made by Sir H. T. De la Beche, the Rev. Mr. Clutterbuck, and several members, on the geological features of the slips, whether occurring naturally in cliffs, as at the back of the Isle of Wight, or in the artificial cuttings of railways. It was contended, that in both cases, the reduction of the lower and softer beds to the state of mud, by percolated water, rendered them incapable of bearing the weight of the superincumbent strata, and that the mass, when saturated, slid down by its own gravity; but that slips in railway work, were accelerated by the vibration caused by the passage of the trains. The vibration of the air from the discharge of a gun had been known to cause an avalanche; and the cases were almost analogous. More attention both to surface and bottom drainage of the slopes was much insisted upon; and it was urged, that the back drains, so close to the top of the cuttings, were prejudicial; that in the dry season the bottoms cracked, the rain found its way through, and it had been frequently noticed that the slips commenced at a few feet below the level of these drains. The dry shafts which had been sunk in the slopes of the Eastern Counties railway, by Mr. Braithwaite, with the concurrence of Sir H. T. De la Beche, were instanced as successful in rendering wet and treacherous strata comparatively dry and secure. A section was exhibited of the embankment at Hanwell, on the Great Western railway; this embankment which was of gravel, was 54 feet high; it was laid in a marshy valley traversed by the river Brent; the London clay, upon which it was laid, inclined towards the river, and at one of the numerous fissures with which the stratum abounds, a subsidence occured squeezing up at the same time on the lower side to as great an extent as the embankment sunk,

which was stated to be nearly as much in one year as the entire mass of the embankment. This subsidence was stopped by loading the foot of the slope, and thus restoring equilibrium, and it was stated to be at present quite secure. It was urged that in the earthwork of canals, where there was no vibration, the slips generally occurred in the first few months after the formation of the embankments; but that, on railways, they occurred quite as frequently after the lapse of several years. It appeared, therefore, that much was due to vibration."—[C. E. & A. Journal.]

ENGLISH PATENTS.

Railway Wheels.—This invention relates to a mode of so combining iron and steel in the manufacture of tyres for railway and other wheels, that the steel may be at those parts of the surface of the iron most liable to wear, after the steel and iron has been rolled into bars for the purposes above described. In order to carry out this invention the steel and iron are piled together, and then heated to a welding heat, after which they are passed under the hammer and formed into a bloom, and then passed between suitable rollers for forming it into bars adapted for tyres for railway and other wheels; by this means the steel is intimately combined, and is said will possess many advantages over the present mode of applying steel to the face of tyres for railway wheels; the patentee in some cases makes the pile so as to present a surface of iron, with steel underneath, the former being removed when turning up the wheel in the lathe in the construction thereof. The claim is for the mode of manufacturing tyres for railway and other wheels, by rolling them from piles of iron and steel, in such manner that the steel is at the wearing surface.

Axles for Wheels.—This invention consists of forming the axles of two parts or shafts, one solid and the other hollow, whereby greater strength, and less liability to breakage is obtained. In order to carry out this invention the patentee provides a tabular or hollow axle sufficiently long to pass through the bosses of each of the wheels when at the required distance from each other, the calibre or bore of this tube being sufficient to admit the solid axle passing through it, which axle consists of a solid shaft having bearings turned at each end, to fit the steps or journals in the frame side of the carriage. The wheels are firmly fixed upon the ends of the hollow axle by means of keys; the solid axle is then passed through the tabular or hollow one, and fixed therein in like manner, by means of keys. When the bearings are within the wheels it will be found necessary in forming the journals to weld two collars upon the hollow axle, so as to obtain greater strength. The claim is for the construction of axles, by combining together solid and hollow shafts one within the other, as described.—[C. E. & A. Jour.]

Separation of Metals.—The inventor takes copper, in which silver is in combination, and melts it in the usual manner; he then pours into an iron vessel containing lead melted to a red heat, or nearly so, and thereby mixes the argentiferous copper with the lead in proportion to the quantity of silver in combination. After the mixture it will be found that the copper with a portion of silver and lead will, as the mixture cools, rise to the surface, which may afterwards be taken off with a pair of tongs, or other mechanical contrivance; for instance, a perforated plate somewhat less in diameter than the size of the iron vessel in which the compounds are, is placed in the vessel, and near the bottom thereof, so that as the metals are melted it will be found that the copper, with a portion of silver, will rise through the perforations in the plate, and may be lifted out of the vessel together with the plate, which plate is provided with one or more handles for that purpose. The copper with such portion of silver as it may yet contain is then broken into small pieces, and separated by the process of "elequation," which is as follows: the pieces of copper thus obtained, together with a quantity of charcoal, are then put into a retort, or retorts, constructed with an opening at one end, through which the metals ("videlicet" the silver and lead contained in such pieces of copper) flow when in a state of fusion. The retorts, which are fixed in the furnace in a sloping position and closed, so as to exclude all air, are then heated to such a degree as to melt the silver and lead, but not the copper, which former are allowed to pass off through the opening at the lower end of the retort into a suitable vessel, leaving the copper almost free from the silver and lead, which two metals are to be afterwards separated by the ordinary process of cupellation.—[Ibid.]

Ellis' Improved Turn Table.—The objection to placing turn tables of the ordinary construction on the main line of a railway, is, that by the nature of their construction, they are rapidly destroyed, by the frequent passage of heavy trains over them, besides the injury done to the carriages, and the upleasant motion and noise. Mr. Ellis has constructed a turn table, which, when not in use, rests firmly on the curb, and thus allows the train to pass rapidly over it without injury. The iron pintle of the table on which it turns being kept well oiled, works with a loose collar round it in a vertical iron case; which case is supported and kept in its central position by two

cross arms of cast iron, at right angles to each other, and attached to the curb. The lower end of the pintle passes through the bottom of the case, below which is a stirrup attached to a cross lever passing at one end through a chase in the circular masonry, or brickwork, supporting the table; attached to the external end of the long lever, is a second lever, working in a vertical direction, and connected with a third, or handle lever, by whidh the table is put in motion or fixed, as required.—[C. E. & A. Jour.]

The "Civil Engineers' Journal," April 1st, gives a rather discouraging account of the "Great Britain," nicknamed, with some show of reason, the "Great Postponed." It appears that the admiralty has engaged the services of Mr. Brunel, to report on screws, and we hope another year will not elapse without enabling us to form a tolerably correct idea of the comparative merits of the different screws, propellers, etc., now in use. We make the following extracts:

TUBES OF LOCOMOTIVE ENGINES.

Investigation to determine the diameter of the tubes of a locomotive engine boiler to produce a maximum effect.

In treating this subject it appears rational to suppose that the effect of the hot air in passing through the tubes is directly in proportion to the extent of surface in contact therewith, and as the time of contact conjointly: that is, denoting the number of tubes by n, their diameter by d, their aggregate surface by s, their united area by a, and the time of contact by t, supposing the length of the tubes constant, we shall have the following postulates:

$$t : a$$
$$a : n\, d^2 \qquad \text{A.}$$
$$\therefore t : n\, d^2 \qquad \text{B.}$$
$$s : n\, d \qquad \text{C.}$$
$$\therefore ts : n^2 d^3 \text{ a maximum D.}$$

Table of the comparative evaporating power of three different methods of tubing:

Number of tubes,	- -	103	78	45
Internal diameter of tubes, inches		$1\frac{5}{8}$	2	3
Distance between centres, "		$2\frac{4}{5}$	3	4
Interval in tube plate, "		$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
Total circumference of tubes "		525·82	490·09	424·05
Total sectional area of tubes "		213·61	245·04	318·08
Product of circumference and area,		112,320	120,091	134,881

Comparison.
$$\text{A} : \text{C} :: 100 : 120$$
$$\text{B} : \text{C} :: 100 : 112$$

It appears from the above, that the boiler which is tubed in the theoretic proportion is from 12 to 20 per cent. superior to the others.

Mr. Buck concludes that with "the preceding theoretic ratio," "the area of the tubes will rather exceed the half of the space."

CONTENTS: